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**University of Salford**  
A Greater Manchester University

**TLQIS**

**Teaching and Learning Quality**

**Improvement Scheme**

**- LEAN -**

**LEAN EDUCATIONAL AND ACADEMIC NUCLEUS**

**Interim Report**

June 2008

## **Rationale and Background**

Lean is an approach to improving business processes such as production. The overall objective of lean principles is to reduce waste and increase value. These principles have been developed and successfully applied within Toyota's product development and production processes since the 1950s. The benefits brought from the application of these principles have been investigated by academia and practitioners. Due to its successful results, the knowledge gathered is gradually being adapted and applied in different contexts such as construction, healthcare and education (Shingo, 1989).

Lean has been mainly associated with the improvement of production processes. However, Toyota has applied the Lean principles within the whole organisation. The results have been widely disseminated and Toyota is recognised as being the more profitable car maker company in the world. The substantial reduction of the production time is one of the recognised achievements of Toyota. Other achievement, for instance, relates to the reduction of the time to market, which is the result of the faster car making product development process. Through the use of lean managerial principles, Toyota has increased its competitiveness.

The lessons learnt from Toyota are now widely spread around the world. Lean is currently undergoing a process of generalisation, associated to the development of a theory-based body of knowledge. The insight that the generic knowledge of lean principles has to be translated to match the requirements of the application context has grown in importance (Koskela, 2000).

The penetration of explicit lean knowledge into service-based industries has been, until recently, very modest. Initial studies and pioneering implementation projects have shown that the utilisation of Lean principles can give manifest benefits in terms of cost, value, client satisfaction and work motivation (De Vries et al., 1999; Lillrank et al. 2004; Sobek II and Jimmerson, 2004).

Considering the underlying assumption of using lean principles for processes improvement, the aim of this research is to investigate how to apply lean principles to the development process of educational programs (theoretical contribution) and how the implementation of these principles can improve the development process of educational programs (practical contribution). Therefore, this research proposal is based on mapping the referred development process and identifying different types of waste, such as over-production; waiting; transporting; inventory; movement, inappropriate processing; defects proposed by Ohno (1988).

## **Project Objectives**

The aim of this research is: "To Investigate the Application of Lean Principles in Service-based Industries". To satisfy the established aim, the following objectives have been identified:

1. Examine in detail the current MSc programme development processes at Salford University and map the as is processes, identifying bottlenecks and exploring the application of Lean principles to better manage these processes;
2. Propose Lean to be processes to improve current practices; and

3. Provide guidelines for improved and seamless management of the development programme.

## **Progress to Date**

In this section a description of the current progress and initial findings are presented.

*Research Method:* since the first proposal the research method has been refined. This research is based on the interpretative school of thought, and therefore it is interested with identifying the 'meaning' of social phenomena as undergone by social actors. The research uses qualitative approaches to understand human experience in context specific settings and construct knowledge from it. More details about tools and techniques for data collection can be found in Appendix 3.

*Literature Report:* a literature review about Lean Production in manufacturing and the application of Lean principles to services (including hotel, healthcare and education sectors) has been produced (Appendix 1). The main finding from the report is that research is needed to better understand how lean principles can be applied to educational environment.

*Interviews:* three interviews have been carried out with members of the development team and a student of the MSc / Pg Dip / PG Cert Built Environment for Healthcare. The interviews followed a semi-structured questionnaire (Interview Protocol – Appendix 2) and initial findings are presented in the next section.

## **Preliminary Findings**

### *The Course (background information)*

The aim of this part-time postgraduate degree programme is to produce reflective practitioners, educating individuals as specialists in the planning, procurement, design, construction and operation of healthcare environments.

In the initial proposal the course had eleven modules (six new modules and five existing ones), however, during the development of the structure of the course, it was agreed that the final course would have eight modules (three new modules and five existing ones). The modules are delivered over a 14 week period which includes assessment through projects. To complete the course students must conclude four modules plus the concluding work. From the four modules, two are compulsory (with six learning packages each) and two are optional from the remaining list of offered modules. The delivery of the course is through e-learning, with the exception of one of the optional modules. There are two options for the concluding work: a research dissertation or the development of two workplace projects.

### *Process*

The development of the MSc / Pg Dip / PG Cert Built Environment for Healthcare, as described by the interviewees, was structured in the format of a business case. The conceptual phase involved the identification of a market need, the identification of the originality of the course as well as possible competitors, current available capacity within the university (including physical assets and human resources).

The output of the idea and concept phase was a draft proposal, which similarly to a business case, had the following information:

- “Course size” (i.e. how many students were targeted per year);
- Target customer (i.e. students’ pre qualifications);
- Necessary technology (including facilities. equipment and software),
- Capacity (existing and needed teaching and learning skills);
- Financial resources (cost of delivery);
- Market needs (considering experts opinion);
- Competition (existing courses with similar content).

With respect to approval(s) the development of the post-grad course had two levels of internal approval and an external validation process. The internal evaluations were at the school and consecutively at faculty levels and both have had an established committee to assess the proposal under development.

The development phase finished with the elaboration of the learning packages for the new modules and the final approval at the faculty level. To monitor the efficiency and effectiveness of the course, a questionnaire is given to the students after the conclusion of each module. Figure 1 presents the course structure as it is currently offered to students.

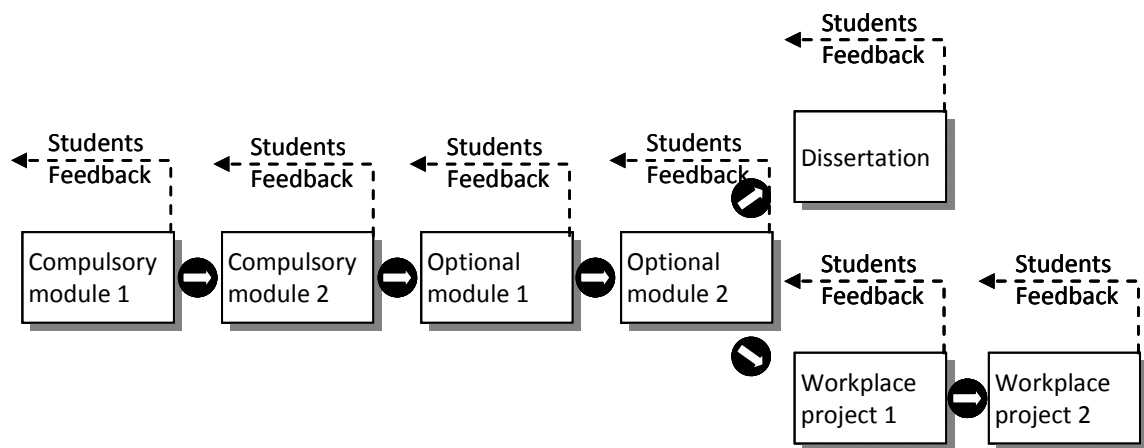


Figure 1 –MSc / Pg Dip / PG Cert Built Environment for Healthcare course structure

### *Stakeholders*

The stakeholders involved in the development of the MSc / Pg Dip / PG Cert Built Environment for Healthcare were academics and industrialists. Academics from both the Faculty of Business Law and the Built Environment and Faculty of Health and Social Care were engaged due to the multidisciplinary scope of the course involving healthcare and construction sectors. Industrialists from the healthcare and construction industries with experience in healthcare construction project development were involved with the aim of sharing their experience, to define the scope of the programme content and validating the course programme in terms of alignment with market needs.

### *Problems*

The problems identified so far are related to the lack of clarity regarding the development process and the internal approval process as presented below.

- According to one of the interviewees, there was no clarity regarding the development process in the beginning. To this interviewee the scope of the project proposal (i.e. the item mentioned in process section) was not clear. In interviewee's own words: “\_It was learning by doing”. Only after being half way through the development process that the interviewee had access to the AQA (Academic Quality Assurance). The AQA is a document which provides guidance in terms of programme development within Salford University.
- There was an expectative (from the development team) that the approval process was an in depth exercise evaluating the course proposal. However, the approval seems to have happened with a focus on check listing the necessary documentation (this needs to be confirmed with other interviewees' point of view). Also, there was lack of clarity about the differences between the school and faculty approval levels.
- According to one of the interviewees, there was a problem related to the submission of the proposal for the development of the MSc course. The approval committee at the faculty level meet regularly every three months and if a deadline for submission is missed, the development team have to wait for three months until the next meeting of the faculty board. This problem was considered a bottleneck in the interviewee's perspective.
- Although the development of the MSc course took two years, according to the interviewee's perspective this time could have been shorter. There were several delays throughout the process that could have been avoided if there was more clarity about the development process.

### *Continuous Improvement and Good Practices*

Opportunities for improvement identified so far are related to new practices adopted to validate the structure and scope of the course as presented below.

- A two days workshop involving academics and industrialists was used to validate module contents against industry needs. It was an ad hoc process activity that, according to the interviewee, gave confidence to the development team. In this workshop, industrialists involved in healthcare development projects made presentations related to their area of expertise and experiences. The group attending the workshop discussed the contents of the presentations aiming at defining the scope of each learning package.

## **Proposed Action**

The results presented in this document are still preliminary and refer to the opinion of the development team. Further interviews need to be conducted to investigate the point of view of the school and university approval board as well as from the students. Two workshops should take place during the research process. The first, involving interviewees have been planned with the aim of validating research findings. The second workshop, involving academics, should be conducted aiming at validate proposed guidelines for improvement based on research findings.

## **Evaluation of Progress**

Due to unforeseen problems the research project has experienced some delays. The research project employed a researcher to start in September 2007, however, due to unforeseen reasons the researcher had to leave his activities in November 2007. Because of the specialised nature of the project, it has been difficult to find some one to take on the role, and we have only recently succeeded in appointing a new researcher with effect from April 2008. Therefore, it is believed that an extension of three months would be necessary to complete the research. We would appreciate consideration of adding this to allow the research to be completed to the fullest possible extent.

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## **Appendix 1 – Literature Review**





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**- LEAN -**

**Lean Educational and Academic Nucleus**

**THE APPLICATION OF LEAN PRINCIPLES ON SERVICES**

**Literature Review**

Ricardo Codinhoto

Mohan Siriwardena

June 2008

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# 1 INTRODUCTION

This literature review presents the principles of Lean production systems and describes how Toyota's Taiichi Ohno took the principles of Henry Ford's production line system, together with the teachings of Deming and Juran and re-engineered these to become the lean philosophy we speak of today. The evolution of lean and its development into new methods and theories for production management will be discussed and their use among different industry sectors is highlighted.

This literature review is structured as follows: chapter one presents the origins of Lean and the main concepts and principles with an emphasis on waste reduction. Chapter 2 presents in more detail the concept of continuous improvement and related tools and techniques. Chapter 3 presents the application of Lean to manufacturing product development and discusses in detail the concept of value and value generation. Chapter 4 presents cases of Lean applied to different industries including hotel, healthcare and education. Chapter 5 presents a summary of the report and final comments. Chapter 6 presents references. Finally a glossary of terms is presented in Chapter 7.

## 1.1 THE ORIGIN OF LEAN: THE TOYOTA PRODUCTION SYSTEM

Lean is a term popularised in the 1980's and 1990's to encompass a number of approaches to managing manufacturing companies that included an emphasis on systems producing exactly what the customer wants at the lowest cost and with no waste (McCarron 2006). The principles behind what is now called 'Lean production' were developed by the car manufacturer Toyota, led by their Chief Engineer Taiichi Ohno (Shingo 1989). Initially Toyota wanted to make the most of the scarce resources following the Second World War, and to improve the overall quality of production and the product that was offered to their customers. Drawing on the theories and teachings of Joseph Juran (1979) and Deming (1982) as well as established production management tools, Toyota developed a new mode of production which was customer focussed and aimed at reducing all waste. These new modes of production included the development of such tools as Just-In-Time (JIT), Kanban replenishment system and 5S).

Lean production had a set of objectives for the production system, such that each car was 'made to order' in line with the requirements of a specific customer but maintaining minimal inventories or intermediate stores in the process.

What was the starting point? Toyota certainly recognised the achievements of Henry Ford and his development of the production line based on creating 'flow-based' production management at Highland Park. The key principle behind Ford's production line was of course based on the large demand for a standard product. The customer demand for different colours, engines and other specifications did not at that time exist, and Ford supplied his standard Model 'T' as fast as possible and in any colour as long as it was black. As market demand matured, however, Model T customers started to demand greater variety, but the Ford production system was not responsive enough to handle these demands.

The emphasis in achieving the customer-focussed delivery mechanism was the elimination of waste (or in Japanese 'Muda'). The Toyota production system was based upon reducing waste and had shifted the focus from craft and mass production (push production system – Figure 1) to consideration of the entire production system (pull production system – Figure 2). The Japanese car manufacturing industry had witnessed the limitations of mass production methods on their overseas visits to US car manufacturing plants. In particular, Toyota observed the US manufacturing plants striving to maintain maximum production by keeping machines running at all times (i.e. economy of scale – the more is produced the smaller is the price per unit). Toyota saw this continuous maximum output as a waste, which led to extensive intermediate inventories. He termed this 'the waste of overproduction', and effectively codified seven types of 'waste' he considered as having the most

detrimental impact. The pressure to keep production lines moving also meant that defects could not be rectified and were further compounded as they moved along the production line. Typically checks on quality were made only at the end of the production line and this led to completed cars having many defects. Toyota developed a production system which aimed to improve production at every stage by rigorously measuring quality and identifying and rectifying the causes of quality issues as they occurred.

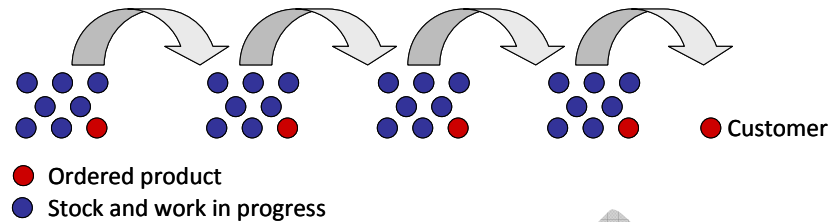


Figure 1 – Push production system

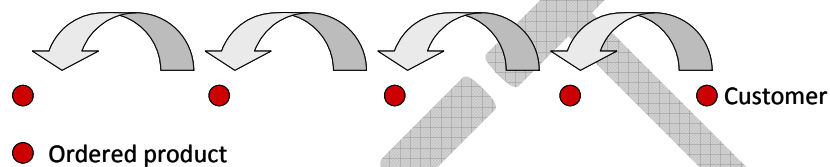


Figure 2 – Pull production system

The resultant rework due to errors adds waste. To help prevent this, Toyota gave workers the power to stop the production line. The whole team would then work together to fix the problem before the production line was re-started. The work-force was thus empowered through decentralised decision making.

Another change implemented in the way production was managed was to decentralise the shop floor management. The use of visual control charts, display daily targets, productivity rates, quality and health and safety measures, enable operators to monitor their performance as well as that of their colleagues (Greif, 1991). These charts were also utilised to highlight any improvements implemented by operators, thereby informing and sharing the learning of individuals and rewarding the originator of the idea. By making production system information visible to everybody involved in the production, it allowed those with first hand knowledge to make decisions in support of the objectives of the production.

This empowerment was taken a step further when instead of inventory being centrally controlled; orders for parts were pulled from the preceding activities using a Kanban system. This 'pull by distribution' replaced traditional production systems whereby large inventories are required to maintain levels of production by pushing production along. The reason large inventories are required in a push system of production is because they are unable to cope with uncertainties in the production system and inventory enables uncertainty to be emergency managed by drawing on buffer stocks.

Pull production reduced the amount of Work in Progress (WIP) which in turn meant that less working capital was required. It also meant that if any design changes came about during manufacture, their impact on production cost was minimised because fewer unwanted parts would need to be reworked or wasted.

The more waste Toyota drove out of the manufacturing stage, the more they realised that there were further reductions to be made, both in the design process and throughout their supply chains.

Lean production continues to evolve but the basic principles can be summarised as the design and development of a production system that requires no inventories and which can deliver a customer's requirements immediately. Lean production is very much about customer focus and linking the

demand with production. Standardised components play their part but the provision of customised products to order, with zero defects and delivery on time are the ultimate goals.

Although the idea of lean has its origin in the (car) manufacturing industry, its ideals and successes can be adapted to other industries like the service or other customer focused industries. The main idea of this research is to study the philosophy of lean, its various forms and variations, see how it has been applied to other industries apart from manufacturing and to examine the possibility of adapting it to the process of developing a new curriculum for the higher education sector.

## **1.2 WOMACK AND JONES' 5 PRINCIPLES OF LEAN**

The basic idea of lean is attractively simple; it is that the organisation should be obsessively focussed on the most effective means of producing value for their customers. An organisation using lean will approach this challenge by: applying 5 basic lean principles; focusing on understanding waste and value in its work and; training staff who do and manage the work to act as improvement teams to bring about change. The 5 principles are:

- Specify what customers Value – Value is what the customer wants and only what the customer wants. This requires a precise understanding of the specific needs of the customer. It is said that up to 95% of process activities are non - value adding. This is probably true, depending on your definition of value adding vs. supporting and waste in a system
- Understand the Value Stream – The value stream are those activities that, when done correctly and in the right order, produce the product or service that the customer values. A lean organisation traces and manages all the activities in the organisation that deliver value wherever they are and whichever department they are in. Activities can be: in whole or part unnecessary and wasteful (and therefore, should be eliminated); supporting the value-adding activities (which should be reduced as far as possible); and customer value-adding (which should be continuously improved)
- Improve the Flow – Flow is described as "the progressive achievements of tasks along the value stream so that a product proceeds from design to launch, order to delivery, and raw materials into the hands of the customer with no stoppages, scrap or backflows"(Womack and Jones, 2003) In a lean organisation work should flow steadily and without interruption from one value adding or supporting activity to the next. This is contrasted with the "batching" of work where, for instance a week's expenses claims are collected for a manager to authorise in one go. Where it is suitable, flow significantly speeds the processing and every effort should be made to eliminate obstacles and bottlenecks that prevent flow
- Pull – The system should react to customer demand, in other words, customers pull the work through the system. In non-lean organisations work is pushed through the system at the convenience of the operators and so you produce outputs that are not required. Most services react to customer demand and so pull the work through the system, synchronisation (timing), alignment (position) and transparency are 3 necessary conditions for "pull".
- Perfection – As the first four principles are implemented it is imperative to understand the system ever better and from this understanding one should generate ideas for more improvement, Perfection is the Continuous Improvement aspect of Lean (Womack and Jones, 2003). A lean system becomes yet leaner and faster and waste is ever easier to identify and eliminate. A perfect process delivers just the right amount of value to the customer. In a perfect process, every step is valuable-adding, capable (produces a good result every time), available (produces the desired output, not just the desired quality, every time), adequate (does not cause delay), flexible, and linked by continuous flow. If one of these factors fails some waste is produced.

'Value' has been identified as a very important part of 'lean' and for 'value' to be added effectively, non-value adding processes have to be eliminated. This 'non-value adding' task is referred to as waste. The next section explores 'waste' and sees which forms it takes in a production process.

### 1.3 CONCEPT OF 'WASTE'

This section will study 'waste' and the different forms it takes in an organisation, either manufacturing or otherwise. To commence, a definition of waste will be established. Waste is often referred to in the lean context as muda. There are two types of waste defined in the lean context, Type I Muda and Type II Muda. Type I Muda is found in activities that add no value to the customer, but are necessary, in the current development framework, to deliver the product. Type II Muda is found in activities that don't create value and can be eliminated immediately, such as waiting and unnecessary transport (MIT, 1999). In lean, waste can be further broken down into 7 specific types:

- Over-delivering – volume, overproduction
- Waiting for the work to be ready for the next process
- Conveyance or transportation
- Over processing – because of poor design (i.e. not producing just what the customer values)
- Inventory levels that are too high
- Human motion
- Correction of defects

To tackle waste in production, Koskela (2000) sets a series of principles as guidelines, including:

- Reduce the lead-time;
- Reduce variability;
- Simplify;
- Increase flexibility;
- Increase transparency

#### 1.3.1 The waste of overproduction

Making too much, too early or 'just-in-case'. Rather than working to meet the specific demand, overproduction means that production is phased ahead of schedule. The aim should be to make exactly what is required, no more no less, just-in-time and with perfect quality. Overproduction discourages the smooth flow of goods or services. Production in erratic bursts is a force against quality and productivity. By contrast, regularity encourages a 'no surprises' atmosphere which may not be very exciting but is much better for planning and management.

Overproduction leads directly to excessive lead time and storage times. As a result defects may not be detected early, products may deteriorate or be damaged, and artificial pressures on work rate may be generated. All these increase the chances of defects. Overproduction also leads to excessive work-in-progress inventories which lead to the physical separation of operations and the discouragement of communication as well as capital tied up in stock.

Yet overproduction is often the natural state. People do not have to be encouraged to overproduce; they often do so 'just to be safe'. Overproduction buys time and enables a comfort or buffer to be developed in case something goes wrong. Often this is reinforced by a bonus system that encourages output that is not needed. By contrast, the 'Kanban' system prevents unplanned overproduction by allowing work to move forwards only when the next work area is ready to receive it. An example of

Kanban can be seen in the fast food industry where Hamburgers are only made at a rate in line with demand and in clerical operations which are most effective when there is a uniform flow of work.

Examples of the waste of overproduction include:

- Manufacturing lead times
- Work in progress
- Bottlenecks
- Obsolescence of goods and products
- Delivery sizes

### **1.3.2 The waste of waiting**

The waste of waiting occurs whenever time is not being used effectively. Time is an important element of competitiveness and quality. Customers do not appreciate being kept waiting but they may be prepared to pay a premium to be dealt with faster. Waiting involves a delay to value adding activities.

On a construction site, for instance, any time that materials or components are seen to be not moving (or not having value added) is an indication of waste. Waiting is the enemy of smooth flow. Although it may be very difficult to reduce waiting to zero, this should always be the goal. Whether the waiting is for materials on site or drawings in the office there should always be an awareness of the effect waiting has on performance and there should be persistent questioning of how the situation can be improved.

When operators and employees are waiting for work, simply waiting for something to enable them to work, or just waiting for some work, this is waste. This waiting time would be much better spent on another operation or on training, cleaning, maintaining, checking, and practising changeovers (or even deliberate relaxation?). All of these are forces for improved quality and productivity. But they require management to have developed a contingency plan on the best use of time. For example if waiting time on site were to be utilised in clearing away rubbish, the site would operate smoother as operatives would have clear and clean areas to work in and the environment would be more conducive to safe working procedures.

Any bottleneck operation that is waiting for work is a waste. Goldratt and Cox (2004) points out that 'an hour lost at a bottleneck is an hour lost for the whole plant'. Effective use of bottleneck time is a key to regular production which, in turn, strongly influences productivity and quality.

Examples of the waste of waiting include:

- Plant breakdowns
- Material shortages/ late deliveries
- Material not being used
- Labour shortages
- Tool set ups/ power failures
- Poor planning or coordination

### **1.3.3 The waste of transportation**

The movement of components and materials on around a site is waste. This wasted transportation has to be paid for and, ultimately, this will fall to the client. Transportation is a waste that can never be fully eliminated but it is also a waste that over time should be continually reduced. The number of

transport and material handling operations is directly proportional to the likelihood of damage and deterioration. Double handling is a waste that affects both productivity and quality. This is classically demonstrated by the 'service' provided by builder's merchants, who order vast stocks of goods from the manufacturers. These are transported to the merchant for storage until ordered from the installer, whence the merchant will add on their mark-up and then deliver them to the point of use.

Transporting is closely linked to communication. Where distances are long, communication is discouraged and quality may be sacrificed. Feedback on poor quality is inversely related to transportation length, whether in manufacturing or in services. There is increasing awareness that for improved quality in manufacturing or services, people from interacting groups need to be located physically closer together. For instance, the design office may be placed deliberately near the production area or site office.

When this waste gains recognition by employees, steps can be taken to reduce it. Measures include monitoring the flow lengths of products and materials through a site or paper through an office. The number of steps, and in particular the number of non-value adding steps, should be monitored. (This can be used as an input into various techniques such as value analysis, nominal group, or time charting.) See Bicheno (1998).

Examples of the waste of transportation include:

- Distances travelled to site and on site
- Material handling
- Delivery to stock or storage
- Empty returns from delivery lorries

### **1.3.4 The waste of inappropriate processing**

Inappropriate processing refers to the waste of 'using a hammer to crack a nut'. In a construction site environment this can be translated to the gang sizes used to complete a task. Rather than flooding a task with labour it may well be far less wasteful to break the task down and allocate its completion to smaller groups or even individual operatives. By doing this the ownership of the task becomes the responsibility of the individual thereby leading to greater efficiency. Using large gangs of operatives to achieve an aim will not help co-ordination or organisation and will also lead to poor lines of communication. So the ideal is to use the smallest possible unit of input (labour or machinery), which is capable of producing the required quality, distributed to the points of use.

Inappropriate processing also refers to machines and processes that are not quality capable; in other words, a process that cannot help but make defects. In general, a capable process requires the correct methods, training, and tools, as well as having the required standards clearly known. The biggest and most common area of waste due to inappropriate processing is realised when a product is delivered to the customer, which does not meet their requirements. Mistake proofing processes utilising techniques such as 'Poka-Yoke' will prevent defects being inherited by process further along the programme and ultimately the client.

Examples of the waste of inappropriate processing include:

- Product not meeting customer requirements
- Order acknowledgements
- Snagging, defects rectification and re-work
- Purchase orders
- Quotations



- Inspection
- Invoicing

### **1.3.5 The waste of unnecessary inventory**

Although having zero inventories is the ultimate aim it is extremely difficult to achieve. Unnecessary inventory is seen as the enemy of quality and productivity. This is so because inventory tends to increase lead-time, prevents rapid identification of problems, and increase space thereby discouraging communication. The true cost of extra inventory is very much in excess of the money tied up in it, for example the cost of storage, transportation and the fact that inventory hides issues of quality of the production system as well as leading to damaged goods.

'Just-in-time' (JIT) manufacturing has taught that inventory deliberately hides problems by covering them up. Over ordering on materials is common on many sites. So, perhaps, a quality problem is not considered important because there are always extra parts available if one is defective. JIT encourages deliberate inventory reduction to uncover this sort of problem. Perhaps the safety of inventory is cut, if nothing happens – fine, you have learned to operate with a leaner system. If stoppage occurs – good, because the problem has been recognised and can now be attacked at its root cause, whether that be the supplier, the storage or the use/installation of the inventory. Such a short term problem, once resolved, will typically lead to much greater long term gains in efficiency.

Examples of the waste of unnecessary inventory include:

- Early deliveries
- Storage space
- Safety stocks/ over ordering
- Shortages due to damage of goods stored for too long

### **1.3.6 The waste of unnecessary movement**

Avoidance of unnecessary movement requires the application of ergonomics for quality and productivity. If operatives have to stretch, bend, pick-up, move in order to see better, or in any way unduly exert themselves, the victim is immediately the operative but ultimately affects the quality and productivity of work and outputs.

This is why an awareness of the ergonomics of the workplace is not only ethically desirable for health and safety reasons, but economically sounds. Toyota is now famous for its quality and is known to place a high importance on 'quality of work life'. Toyota encourages all its employees to be aware of working conditions that contribute to this form of waste. Raising this awareness on a construction site will lead to operatives taking initiative and resolving these problems themselves. The efficient placement of tools and materials for example will enable the waste of unnecessary motions to be minimised.

Examples of the waste of unnecessary motions include:

- Machine watching
- Stretching to reach goods or materials
- Searching for materials/ drawings etc
- Walking to fetch materials/ drawings etc
- Bending
- Lifting

- Congestion through poor work planning

### **1.3.7 The waste of defects**

Defects cost money and time and damage the quality of reputations in the delivery of the product. The Toyota philosophy is that a defect should be regarded as a challenge, as an opportunity to improve, rather than something to be traded off against what is ultimately poor management. That a defect, any defect, is a waste has much in common with the uncompromising 'zero defect' aims of many of today's organisations. The prevention and rectification of defects can be quantified using the principle of Cost of Quality. This enables the financial quantification of all activities involved in the prevention and rectification of defects, see Bicheno (1998).

Defects in construction, for instance, are a major cause of waste as they lead to re-work and/or poor quality; and this has made a major contribution to the poor image of the industry's products. Minimising or indeed completely eliminating defects has to be a serious objective of any construction organisation as this will save them money and their improve reputation through the delivery of more efficient and better quality of service and product.

Examples include:

- Transportation damage
- Paperwork errors
- Lost goods
- Stock loss/ damage
- Rework/ snagging etc

### **1.3.8 Other types of waste**

Since the work of Toyota in identifying the 7 wastes, others have been suggested. These include the waste of human potential or talent, the waste of excess energy or power used the waste of pollution, the waste of space and the waste of unnecessary complexity. Environmental awareness and ecologically sound production is beginning to be recognised as a better way of producing. A claim to a definitive waste which is particularly relevant in construction is 'making-do', which has been proposed by Koskela (2004). Making-do as a waste refers to a situation where a task is started without all its standard inputs, or the execution of a task is continued, although the availability of at least one standard input has ceased. The term input refers not only to materials, but to all other inputs such as machinery, tools, personnel, external conditions, instructions etc.

To summarise, this section had defined 'waste' and identified the 8 wastes types. As mentioned earlier, continuous development is an attribute if a lean organisation. The next chapter will critically look into continuous development; this will serve as a guide to understanding the benefits of organised service delivery and lean organisations.

## **2 THE PHILOSOPHY OF CONTINUOUS IMPROVEMENT**

This section is concerned with the ideals of lean that deals with the constant 'value generation'. Continuous improvement is about relentlessly digging out to get to the root cause of problems instead of scratching the surface. It is about Total Quality Management (TQM).

The Japanese methods for production improvement are becoming more and more widely used in production systems around the world. Lean philosophies originally started within the car manufacturing sector, but the principles are now being utilised in many other industries. One focus of lean is instilling a continuous improvement environment from the shop floor to the senior

management (Liker 2004). This has been influenced by quality management and continuous improvement techniques that were originally taught to top management individuals from Japan in the 1950s by Dr. W. Edwards Deming. Deming along with other quality management gurus such as JM Juran, K Ishikawa, AV Feigenbaum and PB Crosby have developed techniques for quality management, control and improvement and collectively their philosophies and techniques can be combined to achieve Total Quality Management (TQM). Deming developed a 14 point plan which is a complete philosophy of management and is not just about quality, point 5 of this plan is to continuously improve not only products and processes but also all supporting services and activities. The Deming cycle or PDCA cycle is a model for continuous improvement (Figure 3).

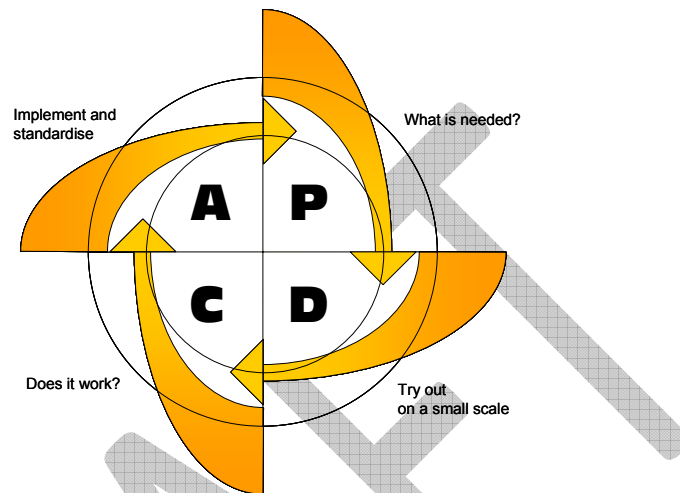


Figure 3 - The PDCA cycle (Deming, 1982)

## 2.1 THE PDCA CYCLE

The four stages of the cycle highlight the necessary procedures for achieving a cycle of continuous improvement; the following describes what is required to be done at each of the stages:

- **Plan:** to improve your operations first by finding out what things are going wrong (that is identify the problems faced), and come up with ideas for solving these problems. For instance, the investigation of the causes for non completion of the plans in the Last Planner System can trigger the plan phase of the PDCA cycle.
- **Do:** changes designed to solve the problems on a small or experimental scale first. This minimises disruption to routine activity while testing whether the changes will work or not. First run studies follow the Plan-Do-Check-Act cycle (see First Run Studies in the Glossary of Terms).
- **Check:** whether the small scale or experimental changes are achieving the desired result or not. Also, continuously check nominated key activities (regardless of any experimentation going on) to ensure that you know what the quality of the output is at all times to identify any new problems when they crop up.
- **Act:** to implement changes on a larger scale if the experiment is successful. This means making the changes a routine part of your activity. Also Act to involve other people (other departments, suppliers, or customers) affected by the changes and whose cooperation you need to implement them on a larger scale, or those who may simply benefit from what you have learned (you may, of course, already have involved these people in the Do or trial stage).

Finally, once the cycle is complete, start again at the beginning by planning the further improvements to your operations. This cycle should continue ad-infinity and thereby foster an environment for continuous improvement.

The recurring theme among all of these gurus, Deming's model being specifically highlighted, is one of continuous improvement or 'kaizen', which is the Japanese name for it. The use of the word Kaizen in English has become widespread across many industries. Originally made popular as a term used in the West by Maasaki Imai whose book of the same name was published in 1986, Kaizen can be split into two parts, the philosophy and the set of tools to utilise in achieving continuous improvement. The definition of kaizen is the continuous improvement resulting from frequent but small gains; the less well known Japanese improvement methodology is 'kaikaku': improvement that results from infrequent large gains. Several tool, methods and techniques have been developed to identify problems and to tackle the continuous improvement idea. Some of these tools are presented in the following sections.

## **2.2 TOOLS AND TECHNIQUES**

In this section three tools/techniques related to continuous improvement are presented. These are: 5 Whys, Ishikawa diagram and 5S. These tools have been used to the identification of problems within production of goods, as well as their route causes.

### **2.2.1 The "5 Whys"**

The 5 whys is a technique employed to ensure that the root cause of a problem is properly identified. Toyota have shown from experience that you need to ask 'why?' five times before the respondent tells you why something has happened which is the true root cause of a problem.

This very simple technique highlights the fact that the first reason or answer to a question relating to a problem will not necessarily direct you to the root cause of the problem. The benefits, circumstances and application of the 5 whys is described below:

The benefit of employing the 5 Whys technique can be summarised as follows:

- Help identify the root cause of a problem.
- Determine the relationship between different root causes of a problem.
- The 5Ys technique is simple; easy to complete without statistical analysis.

The methodology for completing the 5 Whys can be described in 4 simple steps as follows:

- Write down the specific problem. Writing the issue enables the problem to be formalised and described completely. It also helps the individuals or team concerned to focus on the same problem.
- Ask why the problem happens and write the answer down below the problem.
- If the answer that has been provided doesn't identify the root cause of the problem that has been identified in step 1, ask why again and write that answer down.
- Loop back to step 3 until the team is in agreement that the problem's root cause has been properly identified. This may take fewer or more times than asking why five times.

### **2.2.2 The Ishikawa Diagram**

When utilizing a team approach to problem solving, there are often many opinions as to the problem's root cause. One way to capture these different ideas and stimulate the team's brainstorming on root causes is the cause and effect diagram, commonly called a fishbone or Ishikawa diagram. The fishbone diagram (Figure 4), popularised by Kaoru Ishikawa in the 1960s will help to visually display the many potential causes for a specific problem or effect.

The 'fishbone' referred to by this tools name are in this case the 5Ms; men (people), machines, materials, methods and measurement. The idea of this tool is to ensure that whenever a process

improvement or a problem solution is being sought that all of the 5 M's are given due consideration. By taking the 5M's (this could equally be applied to products, process, plant, performance or any other set of causes) and asking the 5 whys for each it is possible to utilise the Ishikawa or fishbone diagram to analyse the root causes and their effects on a specific problem. For this reason this method of problem analysis is also known as a cause and effect diagram. The Ishikawa diagram is an effective way of achieving continuous improvement by enabling problems to be identified and thereby rectified at the root cause. It allows its users to brainstorm the possible contributing factors to a particular problem or defect by asking the 5 whys around each of the 5 M's. An example of how this works is given in Figure below.

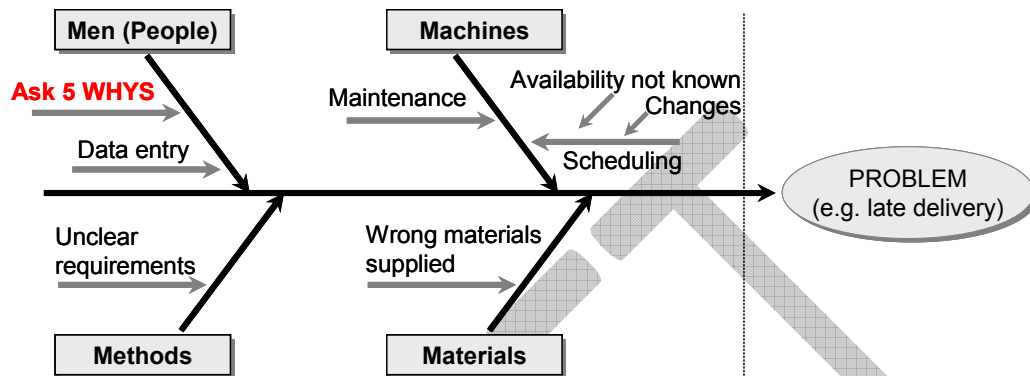


Figure 4 - Ishikawa Diagram

In using the Ishikawa diagram it can be seen that the contributing causes to the problem of a late delivery have been highlighted and these are arranged in a hierarchy of their overall contribution to the problem. It can be seen that the causes are grouped against Men (people), Machines (or plant), Methods (or processes) and Materials (or parts), the measurement step is used to estimate and monitor the performance of each in order to realise any improvement and ascertain whether the changes that have been made have had the desired impact on improvement.

### 2.2.3 The 5S Concept

Continuous improvement requires improvement in many areas, including productivity and quality. The 5S concept takes its name, not surprisingly from 5 Japanese words beginning with the letter 'S'. These Japanese words can be either translated into 5 English 'S' words or alternatively 5 English 'C' words or the acronym CANDO. The version which is ultimately used is not important but the correct and proper application of them is. Table 1 identifies what each of these sets of words are and an explanation of what they mean in practice follows. Each of the sets of terms is the same and just expresses it in different ways. It is the principles that matter and the variations are highlighted in order that you will be aware that they are all from the same concept.

Table 1 - The 5S Table

Japanese 5S's	English 5S's	English 5C's	CANDO
Seiri	Sort	Cleanup	Cleanup
Seiton	Straighten/Simplify	Configure/Organise	Arrange
Seiso	Scrub	Clean/Check regularly	Neatness
Seiketsu	Standardise	Conformity	Discipline
Shitsuke	Self Discipline	Custom/train/Routine	Ongoing improvement

- **Sort or Cleanup:** this is the first stage of the five and is aimed at removing all unnecessary items from the workplace that are not planned for use in the period ahead and includes dirt and rubbish. Items which should be targeted for removal include, among others, furniture, paper, materials, inventory, plant and tools. By removing these items time is not wasted and immediate improvements can be gained. Examples of this type of removal would include a clean desk policy in an office or not allowing storage of materials on site.
- **Straighten, Configure and Arrange:** once the sorting has been carried out the next step is to straighten things up or get some orderliness in the work environment. This will also help minimise the 7 wastes identified in LP3. Examples of orderliness include clear labelling standards, shelves within easy reach, having specific locations for specific materials which enable ease of use (however, only for those materials which are to be utilised in the period ahead). Being organised will enable productivity to increase as time will be spent on adding value rather than searching for items etc.
- **Scrub, Check regularly or Neatness:** once the work environment is clean and correctly configured it is then important that this environment is maintained through keeping things clean and ready to go. The Checking and scrubbing referred to should not be delegated to a cleaner but rather carried out by the owner on a regular and ongoing basis. This stage of the 5 steps includes identifying who is responsible for what cleaning and checking and allocating and monitoring those tasks accordingly.
- **Standardise, Conformity or Discipline:** this stage refers to the establishment of workplace procedures and to the maintenance of standards. Standards (Nakamura 1993) enable the establishment of further and continuous improvements and form part of the PDCA cycle. The standards and procedures which are established should also cover not only what should be done during normal circumstances but should also explain what to do in abnormal circumstances.
- **Self-discipline, Custom and Ongoing Implementation:** this step amounts to the identification and allocation of responsibilities to people while establishing a regime for review. If at all possible building into a process a failsafe or an automatic signal warning to check or do something ('Poka Yoke') will enable self-discipline. A simple example of this might be setting your computer to automatically back-up your hard-disk information.

The commitment and demonstration that the management team are as involved and take as seriously these steps as everybody else is expected to, will result in buy-in being achieved and the successful achievement of savings in wastage. These steps will also enable a culture of continuous improvement to be established. This entire chapter had been looking at the contextual nature of continuous improvement and getting to understand issues better so that value can be added for the customers. The next 2 chapters will be focusing on the practical application of 'lean' in various settings.

### **3 LEAN IN PRODUCT DEVELOPMENT (MANUFACTURING)**

Product Development or Realisation can be defined as the process by which the inception, conception, development, production, use; maintenance and demolition or decommissioning of a facility (constructed works) can be described and managed. The Product realisation process in construction encompasses a wide variety of traditionally disjointed tools, techniques, organizational and management structures and practices. The underpinning theories governing such a process have been evolving more rapidly in the past two decades (Kagioglou et al., 2007). Although a product can be material or immaterial, e.g. a service, for the cause of this section, we will refer to a product as a material product.

Product Development or Realisation is the set of activities beginning with the perception of a market opportunity and ending in the production, sale, and delivery of a product. There are varied but

similar views (models) on the stages involved in Product Development as presented in the examples below.

- Clark and Fujimoto (1991) which included: Concept Generation, Product Planning, Product Engineering and Process Engineering.
- Clark and Wheelwright (1993) had four phases in his including: Concept Development, Product Planning, Product/Process Engineering and Pilot Production/Ramp-up.
- Anderson (1997) outlines 5 phases which are: Product Definition, Architecture, Design, Ramp-up and Follow-up.
- Ulrich and Eppinger (2005) had a model of 5 stages including: Concept Development, System-Level Design, Detail Design, Testing and Refinement and Production Ramp-up.

It can be seen that all the views expressed above are quite similar in approach; all involves a “start/inception” and a “finish/completion”. The only difference is the boundaries of each stage or phase.

The main reason why companies develop new products is to add value to the ever changing need of the customers as well as to remain relevant in the market. “A capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer.” The product developed must be valuable, hence value is defined as the reason between perceived benefits and perceived sacrifices involved in getting those benefits as presented by Monroe (1990) and Saliba and Fischer (2000)

$$\text{Value} = \frac{\text{Perceived Benefits}}{\text{Perceived Sacrifices}}$$

In the equation above, value relates to client expectation and to which extent the product satisfies the clients’ needs. “Value” in the lean world is “a capability provided to a customer at the right time at an appropriate price and as defined in each case, by the customer” (Radeka and Sutton, 2007)

In the first conceptualization, production is viewed as a transformation of inputs to outputs, through a process (Figure 5). A “process” is no more than the steps and decisions involved in the way work is accomplished (Handbook of basic Process Improvement 1996). Production management equates to decomposing the total transformation into elementary transformations, tasks, and carrying out the tasks as efficiently as possible (Koskela, 2000; Bertelsen and Koskela, 2002).



Figure 5 - Process as a transformation

In manufacturing for example, between the Input and the Output (as shown in the figure above), there has been a process and the output itself would most like been a product, that is a full transformation. But there are many of such processes involved before the output is derived at, in that case, the transformation process can be decomposed into sub-processes, which also are transformation processes. This idea, presented in Figure 6, of breaking up the total transformation (production) into smaller, more manageable transformations is actually equivalent to analytical reductionism, a well-known notion in the history of philosophy (Koskela, 2000).

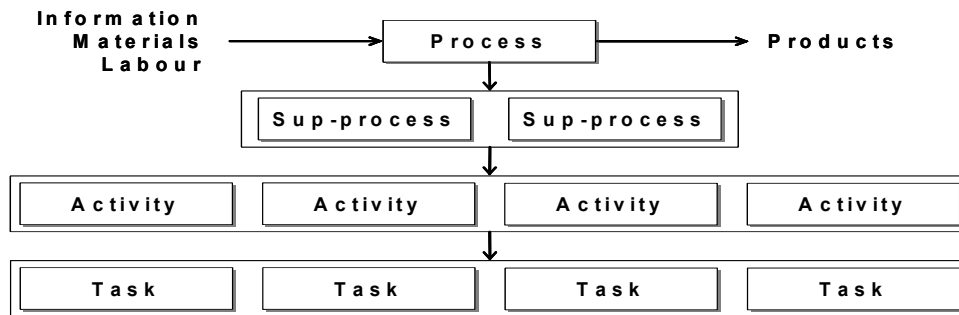


Figure 6 - Process levels

The above diagram shows the subdivision of the many processes and sub-processes involved in a transformation, however it is necessary to understand that in addition to these processes, there are such activities as waiting, moving, inspection etc stages involved in the flow of activities. The diagram below (Figure 7) illustrates the flow concept of production.

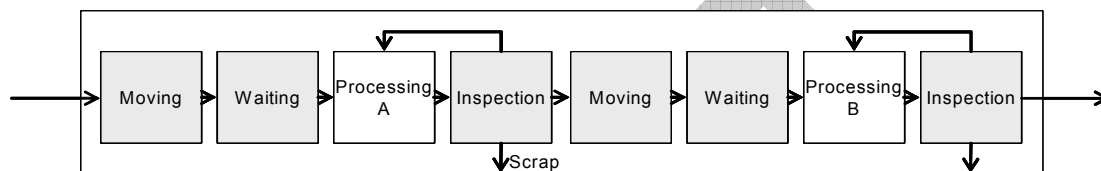


Figure 7 - Flow Concept of Production

### 3.1 VALUE GENERATION

The rationale of the value generation concept of production can best be recognized by contrasting it to the transformation concept (Koskela, 2000). The third conceptualization views production as a means for the fulfilment of the customer needs (Figure 8 and 9). Production management equates to translating these needs accurately into a design solution and then producing products that conform to the specified design (Koskela, 2000; Bertelsen and Koskela, 2002).

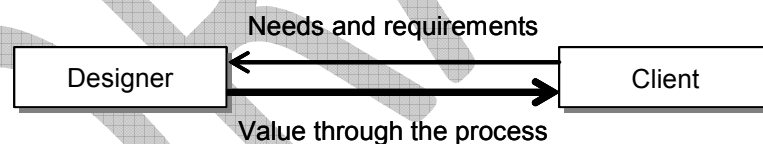


Figure 8 - Value generation concept of design and product development

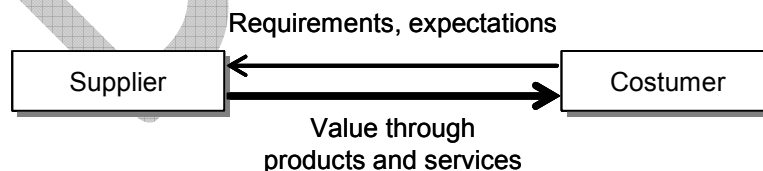


Figure 9 - Value generation concept of production

Koskela (2000) argues that this model is a black box model: it does not tell us anything about the internal mechanisms inside the supplier, ensuring value generation. In order to be operational, the black box in the value generation model has to be opened. A first consideration is to discover which the major subsystems are and what happens in them. Shewhart (1931) in Koskela (2000), speaking of mass production, recognized two subsystems: product design and production. However, for a general case, we have to take a third subsystem, namely order-delivery. The situation is depicted in Figure 10. In the design function, the wishes and requirements of the customer are translated into a product design and specification. In the order-delivery function, an appropriate due date is set based,



among other things, on information from the customer. In the production function, the product design and specification, as well as the due date control the transformation of production factors into the product and the associated flows.

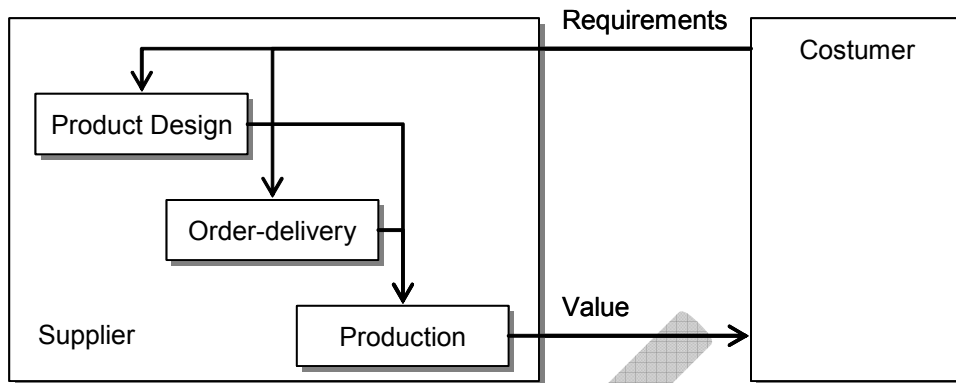


Figure 10 - The black box of value generation opened.

The major difference between the transformation view and the value generation view is that the customer is included in the conceptualization of the latter. Whereas the transformation view assumes that customer requirements exist at the outset, and that they can be decomposed along with work, the value generation view admits that at the outset, customer requirements are not necessarily available or well understood, and that the allocation of requirements to different parts of the (project) product/service is a difficult problem (Koskela and Howell, 2002).

## 4 LEAN THINKING AND PROCESS IMPROVEMENT

The following sections focus on the applicability of lean in different sectors e.g. product development, service industry and educational development etc; the main advantage of this is to explore how widely applicable lean thinking is.

Lean thinking provides a way to specify value, line-up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively. In short, lean thinking is lean because it provides a way to do more and more with less and less human effort, less equipment, less time, and less space while coming closer and closer to providing customers with exactly what they want (Womack and Jones 2003).

### 4.1 BENEFITS OF LEAN PRODUCT DEVELOPMENT

#### 4.1.1 Lean in Service Businesses

Due to its benefits, lean techniques have been continually implemented in manufacturing firms in many sectors. Its adoption in different industry sectors (e.g. services) is based on the assumption that if these established, well proven and well documented approaches can generate benefits on the factory floor, thus they must also be relevant to other industries and processes (Stokes 2007). Although the idea of lean is well embedded in the manufacturing sector, Atkinson (2004) took an in-depth look at the financial sector and identified areas where lean can be implemented. To this author, all businesses aim at making profit, therefore profit can increase through the reduction of waste. Atkinson (2004) states that the philosophy of lean appealed to most service companies due to many reasons including:

- As a cost reduction exercise;
- To cope with specific threats to the business – usually associated with poor relations with their customer base or a particular customer;

- Quality of product or delivery problems;
- Requirement to reduce cycle time from order to delivery;
- Launching and delivering new products or services;
- Developing best value;

Although Lean can represent a solution for the problems mentioned above, Stokes (2007) highlights that the implementation of lean philosophies into service industries are not automatic. Stokes (2007) argues that Lean tools and techniques should be adapted to the company context, rather than copied. To Stokes (2007) many companies try to use lean as a quick fix approach to problems and by doing this they are neglecting the continuous improvement element of lean. Engaging in true process improvement, involves seeking to learn what the causes of problems are and to use that knowledge to reduce variation, remove activities that add no value to the product or service produced, therefore improving customer satisfaction.

Poppendieck (2002) emphasizes how lean ideas have transformed some service delivery oriented corporations in America. He mentions the case a new company who changed the basis of competition in the eyeglasses industry by assembling prescription glasses in an hour. Although lenses are arguably manufactured, every prescription lens is peculiar to the specific customer, thus, its assembly and delivery can be seen more like a service rather than a manufactured commodity. The concept of shipping products the same day they are ordered was also a breakthrough concept in the late 1980's. Some other examples include airlines assigning seats as people arrive at the airport, the delivery of packages overnight by post services and computers manufactured to order in less than a week Poppendieck (2002).

The companies applying these ideas of process/service improvement are benefiting from them both by improving processes and therefore reducing waste as well as by increasing value to their products/services by considering clients needs. In the next sections, examples from the hotel, healthcare and educational industry are presented.

#### **4.1.2 Lean Philosophy in Hotel Services**

Hotel is another sector benefiting from the application of Lean principles. In hotels, due to the level of contact between service provider and the client, it is very important to increase value to customer and improve experience and satisfaction. An interesting example of lean philosophy in hotel business was reported in 2008 by the Lean Learning Center (LLC). Although companies from all over the world send associates to attend classes about lean at this hotel, the management team of the hotel never felt a need to attend such classes. However, after seeing different types of companies staying at the hotel, the operations manager decided to attend the program for Lean training. After learning about the application of some basic lean principles the operations manager changed her vision of the ideal state.

The first learnt lesson was related to the relationship between client and service provider. To the operations manager daily interaction with guests was not necessary and a waste of time considering the amount of daily tasks needed to be dealt with. To the operations manager, to solve daily and recurrent problems was part of the job and without the problems the job was not necessary. However, the operations manager realised that listening to customers and equipping employees to support guests would create more stable processes. Therefore, fewer problems would happen and "not being needed" considered a sign of a "well-oiled machine". The second lean step adopted by the operations manager was to listen to the employees. The idea was to have the employees, not the hotel guests, as the direct clients. The objective was to understand what each employee needed in order to perform his/her tasks. This allowed better job design and increased focus on work and functions that would provide greater value to the guests. Lastly, the hotel designed a responsive system. The operations manager was there to support the employees who, in turn, served the

guests. The roles and responsibilities of the operations manager was rethought and re-examined and in order to consider employees as clients.

Considering the actions taken, for example, in assessing what was needed, it was identified that the room cleaning process could have more support and structure. To accomplish this, a member of the cleaning staff was appointed as team leader. This person has, after the implementation of lean principle, many responsibilities (e.g. getting parallel processes such as laundry started earlier instead of having to wait until everything was collected, performing room inspections to ensure quality and coaching staff on key job skills). Most importantly, several bottlenecks were identified. For instance, the bedroom cleaning was restructured. For this process, it became a standard protocol that when one of the cleaning crew enters a room and recognizes that the standard 50-minute cleaning time will be exceeded; the team leader is called in for backup. This ensures that every room will be done on time without adversely affecting the rest of the cleaning schedule. Small changes like this have made cleaning more efficient and effective and, most importantly for the guests, cleaning is now more predictable and reliable. And, despite appointing one of the existing crew to the new team leader role, the hotel hasn't had to increase any paid-hours because of the efficiencies that were gained. As a result of applying lean to its operations, in less than one year the hotel's service score rose 10 points to 87 and went from the bottom half to the top 10 percent in its peer group. This improved score not only positively impacts hotel guests, but it also impacts the hotel's bottom line through repeat customer stays.

#### 4.1.3 Lean Application in Healthcare

The Lean principles developed from the Toyota Production System, have also been applied in the Healthcare industry. In the UK, the NHS collaborates with many academic and professional institutes to research into lean applications in the service delivery sector and to see how the healthcare sector can benefit from it. Ward (2006) argues that the main benefits obtained by the use of lean principle to healthcare delivery are:

- Improvement the quality of patient care;
- Improvement in safety;
- Reduction of delays;
- Reduction of length of stay whilst using less resources;
- Improvement in patient experience.

One example of an initiative related to the implementation of Lean principles in healthcare is the NHS Institute for Improvement and Innovation. The NHS (2008) argues that there are very positive implications of applying lean principles to healthcare delivery. These implications are presented in Table 2 in line with the five lean principles.

Table 2 - Lean and its Implication in Healthcare (Source: NHS 2008)

Principles	Implications for Healthcare
<b>Specify value</b>  This can only be defined by the customer. Value is any activity which improves the patient's health, well being and experience.	In healthcare we need to identify and agree what value we provide to customers. Anything that improves patient care and experience is adding value, anything else is waste, e.g.: <ul style="list-style-type: none"><li>• less waiting and delay</li><li>• better outcomes</li><li>• fewer adverse incidents</li></ul>

<b>Identify the value stream or patient journey</b> This is the core set of actions required to deliver value for patients	It covers the whole patient journey from start to finish. Identifying which steps add value and improve quality for the patient.
<b>Make the process and value flow</b> Align healthcare processes to facilitate the smooth flow of patients and information.	For a patient this means: <ul style="list-style-type: none"> <li>• Avoiding queuing and batching</li> <li>• Avoiding multiple referrals</li> <li>• Removal of all obstacles which prevent the quickest safest practical flow of care</li> </ul>
<b>Let the customer pull</b> The customer should begin to pull products or services as needed. We should deliver care on demand, with the resources needed for it	We need to create pull in the patient journey. Every step in the patient journey needs to pull people, skills, materials and information towards it, one at a time, when needed. This means responding to demand, rather than handing off patients and pushing them from one department or ward to another. For example: A ward phoning for the next patient rather than waiting for the request.
<b>Pursue Perfection</b> Develop and amend processes continuously in pursuit of the ideal	For the patient, this means completing their case and treatment With the best outcome With no mistakes On time Without delay

Another example is presented by Poppendieck (2002) who describes the story of improving scheduling in a large Health Maintenance Organisation (HMO) by using lean principles. According to this author, following the implementation of lean principles, the majority of their patients were able to see a doctor, independently of the medical speciality, within a day or two of their call. In this case, the HMO management team decided to work-off their schedule backlogs by extending their hours, and then vary their hours slightly from week to week to keep the backlog to about a day. True, the doctors did not have the comforting weeks-long list of scheduled patients, but in fact, they were seeing just as many patients for the same reasons as they did before. Patients were highly satisfied and doctors detect medical problems far earlier than they used to.

One example of what can be done to identify problem related to the way a healthcare service is delivered and therefore to identify non-adding value activities is presented in Figure 11. In the 'spaghetti diagram presented below, wasted journeys and effort are identified and highlighted allowing staff and service designers to re-think the process for better efficiency and effectiveness.

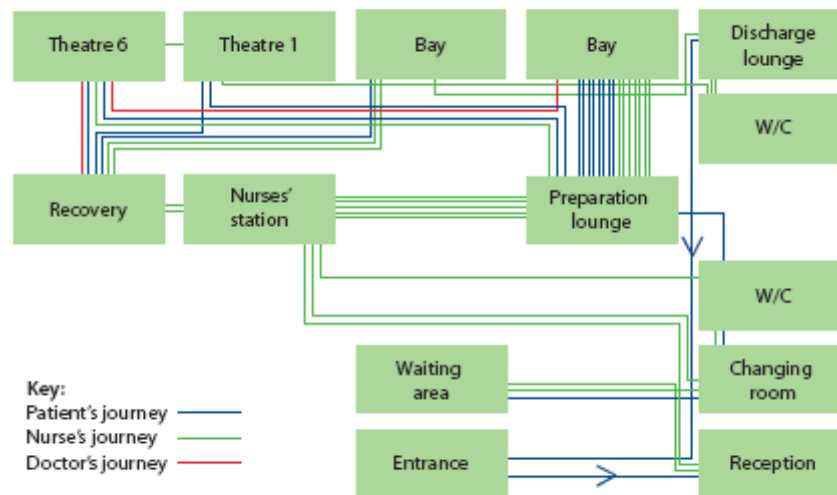


Figure 11 – Patient and Staff journey map (source: NHS, 2006)

In reference to increased effectiveness, evidence gathered by Ward (2006) demonstrates significant improvement of the non-elective trauma patient pathway after the implementation of lean principles. The following outcomes were realised from the lean approach:

- 50% reduction in hospital mortality for older patients with a fractured neck of femur;
- 37% reduction in overall mortality for adult trauma patients;
- 32% shorter length of stay.

Further improvement refers to the fact that no patients were transferred to the long-term rehabilitation ward after the trauma stabilisation unit opened. The above improvements were made using fewer resources than previously required. Additionally, the trauma stabilisation unit implementation team achieved a 30% reduction in time from admission to theatre. The average of 2.5 days fell to 1.7 days for complex adult orthopaedic trauma patients. (Ward, 2006).

#### 4.1.4 Lean application in Higher Education

The education sector can also benefit from the application of lean principles (Alp, 2001, Emiliani, 2005). Although there is very little literature on lean in education development (Alp, 2001, Emiliani, 2005) and even less discussing the academic aspect of education provision. Some universities and institutions of higher education are already applying lean, or sigma 6 to their everyday activities. There are many facets of higher education, that can benefit from the application of lean, for instance, the academic facet, management, student experience, staff aspects, to mention a few. There are some ideas and suggestions from education professionals and consultants on how to effectively apply the principles of lean in education but it is limited in horizon as it mostly looks at education from the point of view of business.

Currently, there is a fierce competition amongst universities in UK (Raifsnider and Kurt, 2004). This relates to the fact that there are many universities and educational institutions, but a limited number of students (Haskings, 2005). If most undergraduate and graduate degree programs are substantially the same, then a likely scenario as presented by Emiliani<sup>1</sup> (2005) will be as such:

<sup>1</sup> Emiliani (2005) has conducted research in the US, therefore, the extent that his statements can be extended to the UK is not known.

- Oversupply of capable and qualified higher educational service providers
- Degree programs that are not differentiated between competitors
- Growth of for-profit educational service providers
- Growth of the distance education market via the Internet
- Having to compete on the basis of price

In a situation as the above, managers and head of this institutions will need to look inwards to see how they can maximize their advantage competitively. In developing degree programmes, the universities will require the assistance of curriculum developers in order to arrange new degree programs that will be compatible with the times and trend.

Thus, to achieve success, universities need to have a competitive advantage. Good quality education is essential, but universities offerings need other attributes to make them attractive to students. One way of improving their chances of attracting students is to improve the levels of service they offer in every customer-facing interaction. To achieve such improvement often times relates to improving internal work processes.

Raifsnider and Kurt (2004) argues that in US higher education institutions can become more responsive and offer better service to students by, for instance, providing real time status to application acceptance, implementing an automated registration system that enables the integration of financial aid to support payment requirements, and integrating a system to retrieve and complete forms online. Xerox Consulting Services in 2005 developed a series of steps they referred to as the DMAIC (**Define, Measure, Analyze, Improve and Control**) approach (Raifsnider and Kurt, 2004). This approach was however management oriented, but it is worth mentioning that they add value to the student's experience. As described by Raifsnider and Kurt (2004) these phases are presented below.

The **Define phase** of the DMAIC process the phase where the current state, problem statement, and desired future state are determined and documented via the Project Charter. Such questions as; what is the problem? What are the expected results what are the signs that the problem has been solved? And how will success be measured? Some examples of common document-related problem statements developed in the Define phase include:

- Because student documents (e.g. registration forms, profile) exist in 10-50 separate locations, schools do not have a single view of complete student files from application to graduate.
- It is difficult for an institution's staff to access or share information that resides only on paper. Documents are easily misfiled or misplaced.
- Work processes are typically organically grown over time based on what works, often without a holistic understanding of impact on other departments or work processes.
- Paper-based work processes are slow, expensive, and cumbersome, which challenges the ability to support admissions.
- Compliance with government mandates like the Patriot Act and Immigration and Naturalization Services (INS Audit) is difficult.
- The ability to provide relevant and timely information to alumni keeps them committed to their academic activities.
- To share paper-based information, workers must make a copy and manually mail, overnight, and/or fax the document.
- Student access to profile information is frustrating for both the student and staff support.
- Paper documents are expensive to store.

The **Measure phase** uses quantitative and qualitative data to get a clear view of the current state. This serves as a baseline to evaluate potential solutions and typically involves interviews with process owners or the workers that are directly involved with the process;

In the **Analyze phase**, the information gathered in the Measure phase is examined, bottlenecks are pinpointed, and improvement opportunities are identified, where non-value-add tasks can be removed. A Value Stream Map is a common tool applied in the Analyze phase to understand an existing workflow process and to uncover inefficiencies.

The **Improve phase** relates to the implementation of the recommended solutions;

Finally, the **Control phase** refers to putting in place the necessary controls to assure that improvements are maintained on the long-term. This involves monitoring and in many cases, publicizing the key process metrics to promote continuous improvement and to guard against regression (Raifsnider and Kurt, 2004). To these authors, the Control phase is where the process manager ensures the solution consistently delivers:

- Improved enrolment by responding quicker to inquiries through process efficiency gains.
- Satisfied students because of convenient self-service access and open lines of communication with staff.
- Productive faculty, staff, and administrators due to faster access to mission-critical information, simpler collaboration with fewer paper-based, labour-intensive tasks, and redundant effort.
- Secure solutions that ensure only authorized personnel have access to confidential information.
- Solutions that, even in the event of a disaster, ensure business continuity because colleges and universities can never shut down.
- Potential to capture records around a life-long learner application to grade so they can be mined for alumni contributions.

## 5 SUMMARY AND FINAL CONSIDERATIONS

This document critically reviews the application of Lean to manufacturing and service sectors, highlighting its origins and principles. Many of the Lean ideals were explored and 'Waste Reduction' and 'Value Generation' emerged as the core values of this philosophy. Lean has many benefits and its application is seemingly universal.

Lean had been applied extensively in the manufacturing industry and many entrepreneurs had extended its values to the service sector in different contexts such as hotel, healthcare and education. The cases studied shows that some valuable gains were made from companies that adopted Lean techniques to their operations. Nevertheless, as revealed in this review, there is very little knowledge about Lean in the Education Industry, although some authors and Lean Consultants had applied (in a limited way) lean principles to the educational sector. One example presented was the DMAIC approach used to improve the process of registering students and cutting waiting times in queues.

Conclusively, this literature review seeks to challenge researchers in Lean Techniques to explore the philosophy of lean in order to develop appropriate models or frameworks that can be used in the process of curriculum development for Institutions of Higher Education.

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## 7 GLOSSARY OF TERMS

**5S:** 5S stands for: Sort, Stabilize, Shine, Standardize and Sustain and refers to a set of activities for eliminating wastes that contribute to errors, defects, and injuries (Liker, 2004). The 5S discipline requires clearing out things which are not needed in order to make it easier and faster to obtain the tools and parts that are needed (Wikipedia).

**ANDON:** visual control device in a production area that alerts workers to defects, equipment abnormalities, or other problems using signals such as lights, audible alarms, etc. (Liker, 2004).

**CYCLE TIME:** This means different things to different academic communities:

- The total time from beginning to end of a process, *as defined by both supplier and customer* (versus 'Lead Time').
- How long it takes to repeat one repetitive process/ product. Total manufacturing cycle time is the time for a process to be completed, e.g. car or house.

**JUST IN CASE (JIC):** Traditional manufacturing is sometimes referred to as Just-In-Case manufacturing by manufacturing engineers. In JIC, manufacturers need to maintain large inventories of supplies, parts, warehousing resources, and extra workers to meet production contingencies.

**JUST IN TIME (JIT):** is a set of principles, tools, and techniques that allows a company to produce and deliver products in small quantities, with short lead times, to meet specific customer needs. Simply put, JIT delivers the right items at the right time in the right amounts (Liker, 2004). This technique shortens cycle times, decreases the amount of inventory that a company carries, leads to low work-in-process, and creates a flexible atmosphere for the type or amount of product that a company would like to run and most of all streamlines work flow through a manufacturing facility (Wikipedia).

**KAIZEN:** Kaizen refers to continuous improvement. Kaizen is a daily activity whose purpose goes beyond simple productivity improvement. It is also a process that, when done correctly, humanizes the workplace, eliminates overly hard work (both mental and physical) "muri", and teaches people how to perform experiments on their work using the scientific method and how to learn to spot and eliminate waste in business processes (Wikipedia).

**KANBAN:** Kanban is the Japanese word for card, ticket or sign and is a tool for managing the flow of production of materials in a Toyota-style "pull" production system (Liker, 2004).

**LEAD TIME:** The amount of time required to meet a customer requirement, *as defined by the supplier* (versus 'Cycle Time'). This can be a complete production cycle or the supply chain cycle, such as the provision of special steels (in both cases, inclusive of shipping, and may include the customer's set up/ pre-processing time). Lead time is often forecast, so that in project management the project lead time would be the overall duration of the critical path.

**MANUFACTURING THROUGHPUT:** The volume of something such as raw material that is processed over a given period, e.g. total manufacturing throughput of a production line or plant.

**POKA-YOKE:** Poka-yoke refers to mistake-proofing (also error-proofing or fool-proofing). These are creative devices that make it nearly impossible for an operator to make an error (Liker, 2004). An example of this in general experience is the inability to remove a car key from the ignition switch of an automobile if the automatic transmission is not first put in the "Park" position, so that the driver cannot leave the car in an unsafe parking condition where the wheels are not locked against movement (Wikipedia).

**SCRUM:** Scrum is a project management method for agile software development. The approach was first described by Takeuchi and Nonaka in The New New Product Development Game (Harvard Business Review, Jan-Feb 1986). They noted that projects using small, cross-functional teams historically produce the best results (Wikipedia).

## **Appendix 2 – Research Protocol**

# TLQIS LEAN SERVICE DESIGN RESEARCH PROJECT

## SEMI-STRUCTURED INTERVIEW PRO-FORMA

April 2008

### **Interviewee's Profile**

Full name and current job function and responsibilities

Role at the MSc Built environment for healthcare course development

### **The description of the development process - dates, times, events, activities**

When was the need for the MSc Built environment for healthcare identified?

When the project started? Which activity/product you considered as a starting milestone?  
When the project was finished? Which activity or product you considered as a finishing milestone?

What were the main stages/milestones the project went through (planning, design, implementation, feedback)? Were targets (content, time, etc) clearly defined for each stage or milestone?

Who was responsible for the development of the MSc?

Were you following any protocol for course development? If yes, which one? When you started using it?

### **Stakeholders**

How many stakeholders (stakeholder groups) were involved in the process? And, more specifically, which stakeholders were involved in design?

What type of involvement each stakeholder group had on determining requirements (sign off power / consultative)? What sources of information did they have access to?

In your view were all the necessary stakeholders involved in the process?

What were the positive and negative impacts of involving stakeholders in terms of cost, complexity and time delays in the process?

Would you recommend any person(s) involved in this process to participate in this research?

### **The requirements capture and management process**

Which methods were used to capture and elicit requirements (e.g. questionnaires, group discussions, records)?

How the information gathered was analysed? Was the importance of requirements ranked? Was the ability to deliver considered? What strategies were adopted in assuring value generation?

What curriculum content (service design) was considered during the design process? How are these considered? When? By whom?

Which requirements were not captured at the front-end but found out later during design? Were there any distortions on requirements or missing validation or verification? Were the requirements well incorporated in the design?

How well each professional group involved supported the client?

How will you judge the requirements capture process?

Is there any provision for the learning from the process to be recorded and preserved for future use?

### **Issues and barriers in the process**

Were there any problems during the process? Why do you think such problems happened?

What would you have done differently? How would you improve the process? How the problems mentioned before could have been avoided?

How learning from MSc course design can best be recorded and preserved for future use?

## **Appendix 3 – Process Mapping**

# **TLQIS LEAN SERVICE DESIGN RESEARCH PROJECT**

## **PROCESS MAPPING – INITIAL RESULTS**

### **INTRODUCTION**

The following process map illustrates the process involved in the development of the MSc / Pg Dip / PG Cert Built Environment for Healthcare offered by the School of the Built Environment (SOBE) at The University of Salford. This document reports the initial results of the research as part of demonstrating the research progress so far. Following a brief description of the rationale and background, the research method is explained in section two. Finally initial research findings are presented.

### **RATIONALE AND BACKGROUND**

Lean is an approach to improving business processes such as production. The overall objective of lean principles is to reduce waste and increase value. These principles have been developed and successfully applied within Toyota's product development and production processes since the 1950s. The benefits brought from the application of these principles have been investigated by academia and practitioners. Due to its successful results, the knowledge gathered is gradually being adapted and applied in different contexts such as construction, healthcare and education (Shingo, 1989).

Lean has been mainly associated with the improvement of production processes. However, Toyota has applied the Lean principles within the whole organisation. The results have been widely disseminated and Toyota is recognised as being the more profitable car maker company in the world. The substantial reduction of the production time is one of the recognised achievements of Toyota. Other achievement, for instance, relates to the reduction of the time to market, which is the result of the faster car making product development process. Through the use of lean managerial principles, Toyota has increased its competitiveness.

The lessons learnt from Toyota are now wide spread around the world. Lean is currently undergoing a process of generalisation, associated to the development of a theory-based body of knowledge. The insight that the generic knowledge of lean principles has to be translated to match the requirements of the application context has grown in importance (Koskela, 2000).

The penetration of explicit lean knowledge into service-based industries has been, until recently, very modest. Initial studies and pioneering implementation projects have shown that the utilisation of Lean principles can give manifest benefits in terms of cost, value, client satisfaction and work motivation (De Vries et al., 1999; Lillrank et al. 2003; Sobek II and Jimmerson, 2004).

Considering the underlying assumption of using lean principles for processes improvement, the aim of this research is to investigate how to apply lean principles

to the development process of educational programs (theoretical contribution) and how the implementation of these principles can improve the development process of educational programs (practical contribution). Therefore, this research proposal is based on mapping the referred development process and identifying different types of waste, such as over-production; waiting; transporting; inventory; movement, inappropriate processing; defects proposed by Ohno, 1995.

### **Aims and Objectives**

The aim of this research is: "To Investigate the Application of Lean Principles in Service-based Industries". To satisfy the established aim, the following objectives have been identified:

1. Examine in detail the current MSc programme development processes at Salford University and map the as is processes, identifying bottlenecks and exploring the application of Lean principles to better manage these processes;
2. Propose Lean to be processes to improve current practices; and
3. Provide guidelines for improved and seamless management of the development programme.

### **RESEARCH METHOD**

This research is based on the interpretative school of thought, and therefore it is interested with identifying the 'meaning' of social phenomena as undergone by social actors (Schwandt, 1994). The research uses qualitative approaches to understand human experience in context specific settings and construct knowledge from it (Tzortzopoulos 2004).

The overall strategy of this research is case study. The case for investigation is the development process of the MSc / Pg Dip / PG Cert Built Environment for Healthcare (MSc BE&H). The MSc BE&H was developed in SOBE - School of the Built Environment (formally School of Construction and Property Management). The MSc BE&H was structured around introducing new teaching modules as well as the incorporation of existing teaching modules offered at MSc level within the Faculty of Business Law and the Built Environment, and the Faculty of Health and Social Care. In this research two levels of analysis have been considered: a) the development process; and b) the delivery process.

### **Data Collection**

The development process will be described by mapping the planning, design and delivery process from the perspective of different participants, and using a standard set of interview questions. The questions are oriented towards constructing a timeline for the major planning activities, focusing on identifying bottlenecks, non adding value-activities as well as good practices in the development process. Additional evidence will be gathered through documents such as Module Specification, Academic Quality Assurance (AQA), and Academic Regulations for



Taught Programmes. The interview questions are presented in Appendix 2, and include the following:

- Interviewee background and role/participation on the project
- The description of the development process - dates, times, events, activities
- Stakeholders involved
- The requirements management process
- Issues and barriers in the process

At least one interview with a representative of each stakeholder group involved in defining requirements for each project will be conducted. The final number of interviews will be defined after all the stakeholder groups are identified. Before the interview, interviewees will receive a copy of the research project brief, clearly presenting the research aims and objectives. Confidentiality will be assured to all interviewees.

### **Process Mapping**

This section describes the process mapping models and techniques that will be used to map the development process at a general (broad) level as well as at the level of detail.

#### *Overall Process Mapping*

An overall map of the process will be generated by using the Process Protocol model developed by Kagioglou et al., (1998). Kagioglou et al., (1998) argues that the concept of the Process Protocol model is capable of representing the diverse interests of all the parties involved in a development process and also provide a complete overview. In addition, the design and production/service operations need to form part of a common process (model) best controlled by an integrated system. This has been achieved successfully in manufacturing and other industries through process modelling and the reengineering of those processes (Rosenau 1996) in Kagioglou et al., (2000). The model suggested by Kagioglou et al., (2000) was developed for the construction sector and therefore it will be necessary to adapt the model to service development context. The phases in the model developed by Kagioglou et al., (2000) and its adaptation to service context are presented in Table 1.

Table 1 – Process Protocol: adaptation from construction to service context

<b>Phase</b>	<b>Construction Context</b>	<b>Service Development Context</b>
Phase 0	Demonstrating the Need	Demonstrating the Need
Phase 1	Conception of Need	Conception of Need
Phase 2	Outline Feasibility	Outline Feasibility
Phase 3	Substantive Feasibility Study & Outline	Substantive Feasibility Study & Outline

Phase	Construction Context	Service Development Context
	Financial Authority	Financial Authority
Phase 4	Outline Conceptual Design	Outline Conceptual Design
Phase 5	Full Conceptual Design	Full Conceptual Design of the Programme
Phase 6	Coordinated Design, Procurement & Full Financial Authority	Check listing available and needed capacity (e.g. facilities, people, equipment)
Phase 7	Production Information	Development of the modules
Phase 8	Construction	Programme
Phase 9	Operation & Maintenance	Programme delivery & Maintenance

The activities undertaken throughout the process (as it happened during the development of the MSc course) will be mapped according to its related development phase as well as stakeholder responsible for undertaking the action. Process loops and bottlenecks will be highlighted. Figure 1 presents the template for mapping the process.

	Demonstrating the Need	Conception of Need	Outline Feasibility	Substantive Feasibility Study & Outline Financial Authority	Outline Conceptual Design	Full Conceptual Design of the Programme	Check listing available and needed capacity (e.g. facilities, people, equipment)	Development of the modules	Programme	Programme delivery & Maintenance
Service Design Team										
SOBE Board										
Faculty of BLBE Board										
Faculty of H&SC Approval Board										
Industrialists										
Students										

Figure 1 – Service Process Protocol (adapted from Kagioglou et al. 2000)

### *Detail Process Mapping*

#### *IDEF-0*

The Integration Definition language 0 for Function Modelling (IDEF-0) process modelling technique was adopted, initially, as the most appropriate means of representing the process investigated in this research. This technique has been used to successfully represent processes such as Sanvido's Integrated Building Process Model (Sanvido, 1990). The IDEF-0 technique has been found to be effective when modelling 'as-is' processes (Erdogan, 2008).

The IDEF methodology is a family of modelling methods that supports a paradigm capable of addressing the modelling needs of an enterprise and its business areas. The IDEF0 technique is based on SADT™ (Structured Analysis and Design Technique), developed by Douglas T. Ross and SofTech, Inc (IDEF, 1993). IDEF-0 can be used to model a variety of automated or non-automated systems by using hierarchical series of diagrams, text, and glossary cross referenced to each other (IDEF, 1993).

The single unit of an IDEF0 model is a diagram (IDEF, 1993). The main features in an IDEF0 diagram are the boxes representing the functions (activities) and different types of arrows indicating inputs, controls, outputs and mechanisms (ICOMs). These main features are shown and explained in Figure 2.

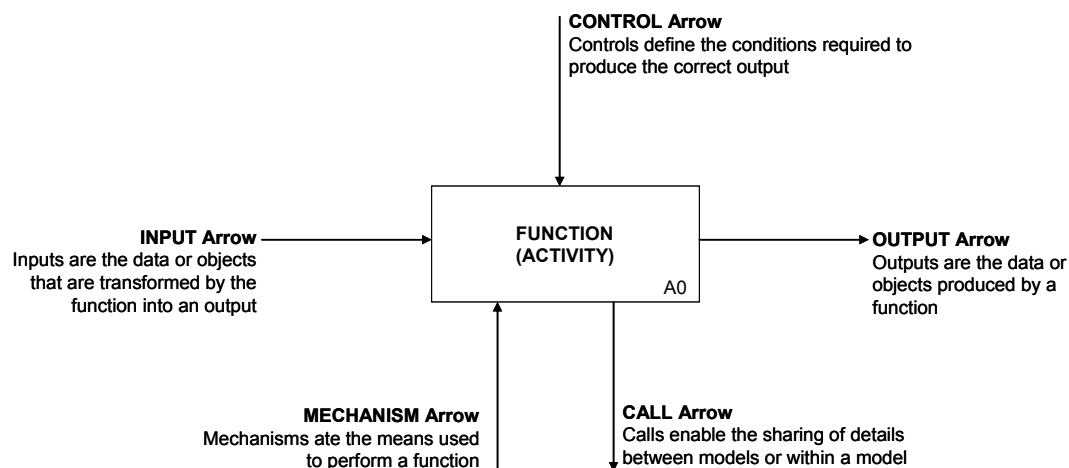


Figure 2 - Activity Box and ICOMs (adapted from IDEF, 1993)

An activity shown in a diagram can be broken down into further activities and can be shown in a separate diagram, called a child diagram. Figure 3 shows an example of detailing activities in an IDEF-0 model. As seen from the figure, each diagram has a diagram node number shown at the lower left corner of the frame. The top level activity is shown as a one-box IDEF-0 diagram which has the node number as A-0. This top level activity is detailed as 3 processes in a diagram with the node number A0. Each process has a node number shown in the right bottom corner of the box to specify its position in the model hierarchy. If a process is detailed in a child diagram, a node reference is also assigned to the process, which is shown below the box. The second function box in the A0 diagram in the figure is an example to this. This function has a node number A2 shown below the box on the right indicating that this process is detailed in a child diagram. Since this child diagram details the A2 process, the node number written in the diagram frame is A2. The first activity in the A2 diagram is detailed in a child diagram with node number A21.

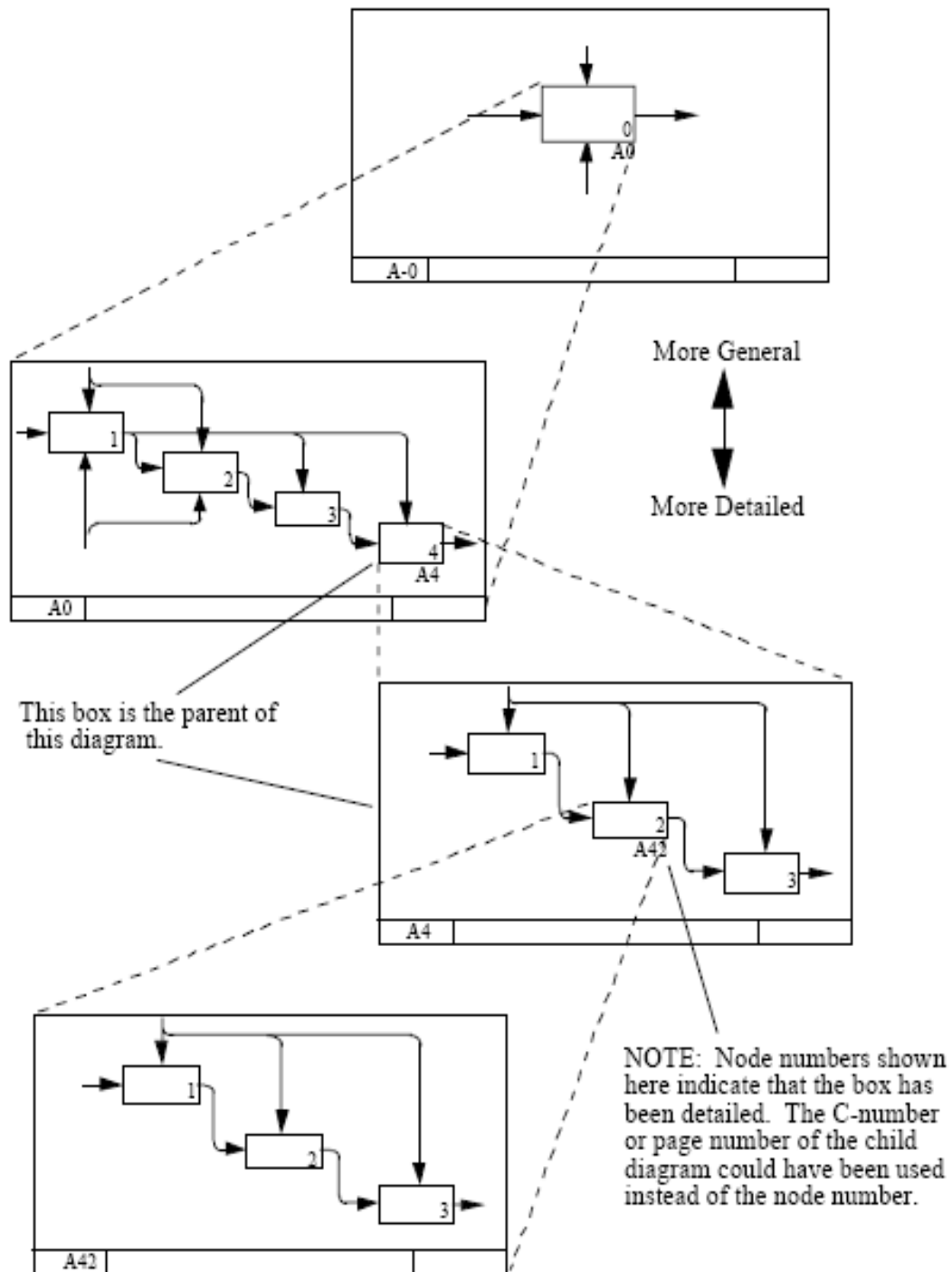









Figure 3 - Detailing an Activity in a Child Diagram (Source: IDEF, 1993)

### *Process Mapping Symbols*

There are many standards for process mapping symbols the key for the author of a process map is to use those symbols which all users of the map will understand. Some standard symbols which are universally accepted are detailed in Table 2.

Table 2. Basic Graphic Symbols (adapted from Ishiwata, 1984)

Symbol	Name	Description
	Operation	Rectangular boxes can be used to represent these too and the description included ascertains the operation type
	Move	Used to represent the transposition or movement of resources, materials or plant for example.
	Delay	Represents a delay in the process, for example, waiting for materials, drawings etc.
	Store	Shows the storage of materials and is usually preceded by an operation, inspection or movement.
	Inspect	Can be used to represent an inspection of either materials, work completed or in progress, plant, drawings, etc.
	Decision	Shows a decision point in a managerial process, this could be for example an accept/reject decision
	Issue	The cloud symbol highlights the fact that there is an issue or query with the process for clarification

These usually represent non-value adding activities

## PRELIMINARY RESEARCH FINDINGS

### *The Course (background information)*

The aim of the MSc / Pg Dip / PG Cert Built Environment for Healthcare is to produce reflective practitioners, educating individuals as specialists in the planning, procurement, design, construction and operation of healthcare environments.

The initial proposal this part-time postgraduate degree programme had eleven modules (six new modules and five existing ones), however, during the development of the structure of the course, it was agreed that the final course would have eight modules (three new modules and five existing ones). The modules are delivered over a 14 week period which includes assessment through projects. To complete the course students must conclude four modules plus the concluding work. From the four modules, two are compulsory (with six learning packages each) and two are optional from the remaining list of offered modules. The delivery of the course is through e-learning, with the exception of one of the optional modules. There are two options for the concluding work: a research dissertation or the development of two workplace projects. Figure 4 presents the course structure as it is currently offered to students.

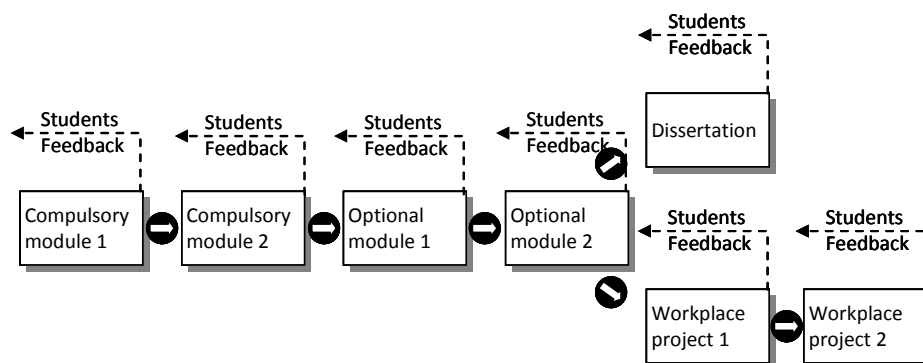


Figure 4 –MSc / Pg Dip / PG Cert Built Environment for Healthcare course structure

## Development Process

As stated in the Salford University procedure for Programme Design, Approval and Amendment 2007/2008, there are two stages to the formal Programme Approval process:

- Stage 1: Outline Approval (planning, resource and rationale information)
- Stage 2: Detailed Approval (academic standards, curriculum and quality of learning opportunities information).

The problem with the representation of the development process as presented in Figure 5 is that time, loops and bottlenecks are not represented. Therefore, the activities presented in this process model needs to be deployed with the aim of identifying non adding value activities and value loss.

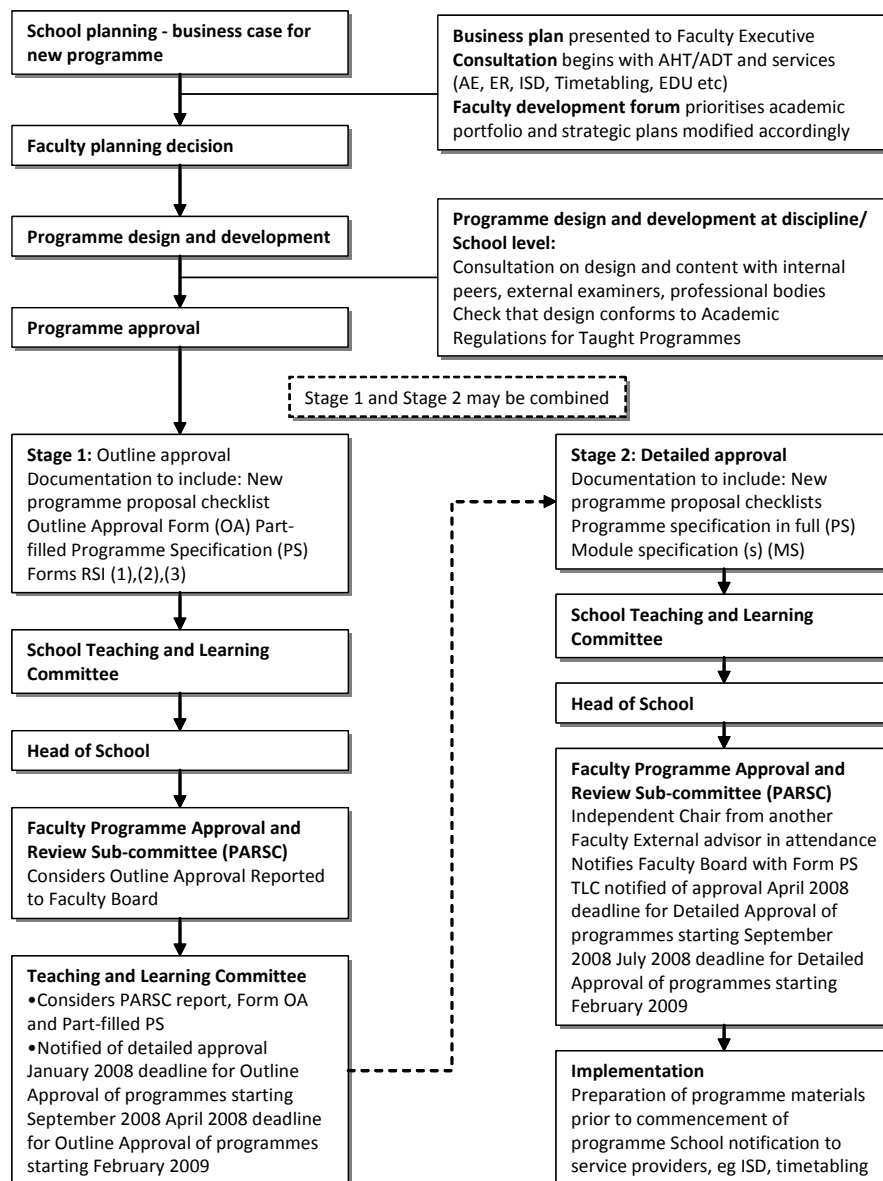


Figure 5 - Programme Design and Programme Approval

### *The Interviewees' Perspective of the Development Process*

The development of the MSc / Pg Dip / PG Cert Built Environment for Healthcare, as described by the interviewees, was structured in the format of a business case. The conceptual phase involved the identification of a market need, the identification of the originality of the course as well as possible competitors, current available capacity within the university (including physical assets and human resources).

The output of the idea and concept phase was a draft proposal, which similarly to a business case, had the following information:

- "Course size" (i.e. how many students were targeted per year);
- Target customer (i.e. students' pre qualifications);
- Necessary technology (including facilities, equipment and software),
- Capacity (existing and needed teaching and learning skills);
- Financial resources (cost of delivery);
- Market needs (considering experts opinion);
- Competition (existing courses with similar content).

With respect to approval(s) the development of the post-grad course had two levels of internal approval and an external validation process. The internal evaluations were at the school and consecutively at faculty levels and both have had an established committee to assess the proposal under development.

The development phase finished with the elaboration of the learning packages for the new modules and the final approval at the faculty level. To monitor the efficiency and effectiveness of the course, a questionnaire is given to the students after the conclusion of each module.

### *Stakeholders*

The stakeholders involved in the development of the MSc / Pg Dip / PG Cert Built Environment for Healthcare were academics and industrialists. Academics from both the Faculty of Business Law and the Built Environment, and the Faculty of Health and Social Care were engaged due to the multidisciplinary scope of the course involving healthcare and construction sectors. Industrialists from the healthcare and construction industries with experience in healthcare construction project development were involved with the aim of sharing their experience, to define the scope of the programme content and validating the course programme in terms of alignment with market needs.

### *Problems*

The problems identified so far are related to the lack of clarity regarding the development process and the internal approval process as presented below.

- According to one of the interviewees, there was no clarity regarding the development process in the beginning. To this interviewee the scope of the project proposal (i.e. the item mentioned in process section) was not clear.

In interviewee's own words: "It was learning by doing". Only after being half way through the development process that the interviewee had access to the AQA (Academic Quality Assurance) document. The AQA document provides guidance in terms of programme development within Salford University.

- There was an expectation (from the development team) that the approval process was an in depth exercise evaluating the course proposal. However, the approval seems to have happened with a focus on check listing the necessary documentation (this needs to be confirmed with other interviewees' point of view). Also, there was lack of clarity about the differences between the school and faculty approval levels.
- According to one of the interviewees, there was a problem related to the submission of the proposal for the development of the MSc course. The approval committee at the faculty level meet regularly every three months and if a deadline for submission is missed, the development team have to wait for three months until the next meeting of the faculty board. This problem was considered a bottleneck in the interviewee's perspective.
- Although the development of the MSc course took two years, according to the interviewee's perspective this time could have been shorter. There were several delays throughout the process that could have been avoided if there was more clarity about the development process.

#### *Continuous Improvement and Good Practices*

Opportunities for improvement identified so far are related to new practices adopted to validate the structure and scope of the course as presented below.

- A two days workshop involving academics and industrialists was used to validate module contents against industry needs. It was an ad hoc process activity. However, according to the interviewee, the feedback received increased the confidence to the development team. In this workshop, industrialists involved in healthcare development projects made presentations related to their area of expertise and experiences. The group attending the workshop discussed the contents of the presentations aiming at defining the scope of each learning package.

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